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UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

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*Ex parte* JAMES M. TOUR, JASON J. STEPHENSON,  
TIMOTHY IMHOLT, CHRISTOPHER A. DYKE,  
BORIS I. YAKOBSON, and JAMES A. ROBERTS

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Appeal 2008-2797  
Application 10/738,459  
Technology Center 1700

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Decided: July 3, 2008

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Before BRADLEY R. GARRIS, CHUNG K. PAK, and PETER F. KRATZ,  
*Administrative Patent Judges.*

PAK, *Administrative Patent Judge.*

DECISION ON APPEAL

This is a decision on an appeal under 35 U.S.C. § 134 from the Examiner's refusal to allow claims 1 through 27, all of the pending claims in the above-identified application. We have jurisdiction pursuant to 35 U.S.C. § 6.

We AFFIRM.

*STATEMENT OF THE CASE*

The subject matter on appeal is directed to a method of crosslinking carbon nanotubes (Spec. 3, para. 0007). This nanotube crosslinking method involves exposing the nanotubes to microwave radiation (Spec. 3, para. 0008). Further details of the appealed subject matter are recited in representative claims 1, 7, 8, 9, 10, 11, 12, 18, 19, 21, 22, 25, and 27 reproduced below:

1. A method of crosslinking carbon nanotubes comprising:

(1) providing carbon nanotubes; and

(2) irradiating said carbon nanotubes with microwaves to yield a plurality of crosslinked carbon nanotubes.

7. The method of claim 1, wherein the plurality of crosslinked carbon nanotubes comprises at least one junction formed via a rearrangement of carbon atoms.

8. A method of crosslinking carbon nanotubes comprising:

(1) providing carbon nanotubes; and

(2) irradiating said carbon nanotubes with microwaves to yield a plurality of crosslinked carbon nanotubes;

wherein crosslinking is generated between the sidewalls of adjacent carbon nanotubes.

9. The method of claim 8, wherein the carbon nanotubes are single-wall carbon nanotubes.

10. The method of claim 8, wherein the carbon nanotubers are chemically functionalized prior to the steps of irradiating.

11. The method of claim 8, wherein the crosslinking comprises covalent bonds.

12. The method of claim 11, wherein the covalent bonds are carbon-carbon bonds.

18. The method of claim 8, wherein the plurality of crosslinked carbon nanotubes comprises at least one junction formed via a rearrangement of carbon atoms.

19. A method of crosslinking single-wall carbon nanotubes comprising:

(1) providing single-wall carbon nanotubes; and

(2) irradiating said single-wall carbon nanotubes with microwaves to yield a plurality of crosslinked single-wall carbon nanotubes;

wherein crosslinking is generated between the sidewalls of adjacent single-wall carbon nanotubes; and

wherein the step of irradiating is carried out in an inert environment selected from the group consisting of ultra-high vacuum, high vacuum, inert gases, and combinations thereof.

21. The method of claim 19, wherein the crosslinking comprises covalent bonds.

22. The method of claim 21, wherein the covalent bonds are carbon-carbon bonds.

25. The method of claim 19, wherein the microwave radiation is generated by a magnetron with a power that ranges from about 1 W to about 10,000 W.

27. The method of claim 19, wherein the plurality of crosslinked single-wall carbon nanotubes comprises at least one junction formed via a rearrangement of carbon atoms.

As evidence of unpatentability of the appealed subject matter, the Examiner has proffered the following prior art references:

Harutyunyan US 7,014,737 B2 Mar. 21, 2006

Fliflet et al. (Fliflet), "Application of Microwave Heating to Ceramic Processing: Design and Initial Operation of a 2.45-GHz Single-Mode Furnace," *IEEE Transactions on Plasma Science*, Vol. 24, No. 3, pp. 1041-1049 (June 1996).

Holzinger et al., (Holzinger), "Sidewall Functionalization of Carbon Nanotubes," *Angew Chem. Int. Ed.*, Vol. 40, No. 21, pp. 4002-4005 (2001).

Tour et al (Tour '168), "Use of Microwaves to Crosslink Carbon Nanotubes to Facilitate Modification," US Patent Application 10/738,168 (Filed Dec. 17, 2003).

Tour et al. (Tour '092), "Process and Apparatus for Microwave Desorption of Elements of Species from Carbon Nanotubes," US Patent Application 10/764,092 (Filed Jan. 23, 2004).

The Examiner has rejected the claims on appeal based on the above proffered evidence as follows<sup>1</sup>:

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<sup>1</sup> As is apparent from pages 3 and 4 of the Answer, the Examiner has withdrawn the §§ 102(b) and 103(a) rejections based on WO 01/75903 and KO 2002-0046342 set forth in the final Office action mailed March 14, 2007. As is also apparent from the final Office action mailed March 14, 2007, the Advisory Action mailed May 24, 2007 and pages 3 and 4 of the Answer, the Examiner has maintained the provisional rejection of claims 1 through 27 under the judicially created doctrine of obviousness-type double

- 1) Claims 1 through 4, 7 through 9, 11 through 15, 18, 19, 21 through 24, and 27 under 35 U.S.C. § 102(e) as anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as unpatentable over the disclosure of Harutyunyan;
- 2) Claims 5, 6, 16, 17, 25, and 26 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Harutyunyan and Fliflet;
- 3) Claims 10 and 20 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Harutyunyan and Holzinger.
- 4) Claims 1 through 27 provisionally under the judicially created doctrine of obviousness-type double patenting as unpatentable over the claims of Tour ‘168; and
- 5) Claims 1 through 27 provisionally under the judicially created doctrine of obviousness-type double patenting as unpatentable over the claims of Tour ‘092;

Appellants appeal from the Examiner’s decision rejecting the claims on appeal under the judicially created doctrine of obviousness-type double patenting, and 35 U.S.C. § 102(e) and § 103(a).

*RELEVANT FACTUAL FINDINGS,*

1. Harutyunyan teaches (col. 7, l. 62 to col. 8, l. 7) that:

[T]he localized heating is preferably induced by exposing the crude reaction product comprising the carbon naotubes and the

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patenting as unpatentable over the claims of copending Applications 10/764,092 and 10/738,168 filed Jan. 23, 2004 and Dec. 17, 2003, respectively,

residual catalyst particles to microwave radiation. Preferably, the frequency of the microwave radiation is about 2.45 GHz and its power is 150 W.

...It is also preferable that there be a substantial difference between the residual particles and the nanotubes or nanofibers in their susceptibility to heating by exposure to electromagnetic fields or radiation at the frequency selected....

2. Appellants do not challenge the Examiner's finding that Harutyunyan teaches at col. 8, ll. 21-24 employing "ultra-high vacuum, high vacuum, inert gases, and combinations thereof" during the exposure of the crude reaction product with microwave radiation. (Compare Ans. 8, 10, 12, with App. Br. 5-19 and Reply Br. 5-11).
3. Harutyunyan teaches "a tuned TE103 single mode cavity driven by a 1.5 kW [150 W], 2.45 GH power supply" (col. 11, ll. 41-45).
4. Fliflet teaches a NRL 2.45 microwave furnace (heating) system employing "the Cober S6F 2.45-GHz industrial magnetron-based [microwave] source which can produce up to 6 kW of continuous wave (CW) power" (pp. 1042-43).
5. Holzinger teaches that nanotubes are chemically functionalized after they are purified (p. 4002).
6. Neither Harutyunyan nor Holzinger teaches that the chemical functionalization of carbon nanotubes can be carried out in the presence of Harutyunyan's catalyst residue impurities. (*See* Hozinger and Harutyunyan in their entirety).
7. Appellants do not challenge the Examiner's determination that claims 1 through 27 are unpatentable over the claims of copending Applications

10/764,092 and 10/738,168 filed Jan. 23, 2004 and Dec. 17, 2003,  
respectively, (*Compare* Ans. 5-6, with App. Br. 5-26 and Rep. Br. 3-13).

#### *PRINCIPLES OF LAW, ISSUES, AND ANALYSES*

##### *I. INHERENCY UNDER § 102 AND/OR 103*

Under 35 U.S.C. § 102, anticipation is established only when a single prior art reference discloses, either expressly or under the principle of inherency, each and every element of a claimed invention. *In re Spada*, 911 F.2d 705, 708 (Fed. Cir. 1990). The predecessor to our reviewing court in *In re Best*, 562 F.2d 1252, 1255 (CCPA 1977) provided a guideline for resolving inherency as follows:

Where... the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical process, the PTO can require an applicant to prove that the prior products do not necessarily or inherently possess the characteristics of his claimed product...[w]hether the rejection is based on "inherency" under 35 U.S.C. § 102, on "prima facie obviousness" under 35 U.S.C. § 103, jointly or alternatively, the burden of proof is the same , and its fairness is evidenced by the PTO's inability to manufacture products or to obtain and compare prior art products.

According to *In re Cruciferous Sprout Litig.*, 301 F.3d 1343, 1349 (Fed. Cir. 2002):

Under the principles of inherency, if the prior art necessarily functions in accordance with, or includes, the claimed limitation, it anticipates. ... Inherency is not necessarily coterminous with the knowledge of those of ordinary skill in the art. Artisans of ordinary skill may not recognize the inherent characteristics or functioning of the prior art.

*See also Schering Corp. v. Geneva Pharmaceuticals*, 339 F.3d 1373, (Fed. Cir. 2000)(rejecting the contention that inherent anticipation requires that a person of ordinary skill in the art at the time would have to recognize the inherent feature at issue).

Here, the Examiner takes the position that Harutyunyan necessarily or inherently crosslinks its carbon nanotubes in the claimed manner since they, like Appellants' nanotubes, are exposed to microwave radiation under the claimed conditions (Ans. 8-13). On the other hand, Appellants contend that Harutyunyan does not produce such crosslinking since "Harutyunyan is not irradiating the carbon nanotubes" (e.g., App. Br. 6 and Reply. Br. 5). In support of their contention, Appellants refer to Harutyunyan's teachings directed to localized heating of metal and/or catalyst residual impurities for the purification purpose (*id.*).

The dispositive question is, therefore, does Harutyunyan teach exposing carbon nanotubes to the claimed microwave radiation under the claimed conditions, thereby providing a reasonable basis for finding inherency within the meaning of 35 U.S.C. § 102(e)/103 (a)? On this record, we answer this question in the affirmative.

Although Harutyunyan does not mention that its carbon nanotubes are crosslinked in the manner recited in claims 1, 7, 8, 11, 19, 21, 22, and 27, we find that Harutyunyan teaches exposing both carbon nanotubes and residual catalyst impurities to microwave radiation at the claimed frequency and power in an inert environment under high vacuum to cause localized heating of the metal or catalyst residue impurities as indicated *supra* (FF 1-2). Because Harutyunyan's nanotubes, like the claimed nanotubes, are exposed

to the claimed microwave under the claimed conditions, we concur with the Examiner's finding that Harutyunyan's carbon nanotubes are inherently or necessarily crosslinked in the claimed manner. The burden, therefore, is shifted to Appellants to show that the exposure of carbon nanotubes to microwave radiation in the manner taught by Harutyunyan does not produce the claimed crosslinking. However, Appellants have not carried their burden of proof (App. Br. 5-19 and Reply Br. 5-11). Appellants have not proffered any objective evidence to show that Harutyunyan's carbon nanotubes are not necessarily crosslinked in the manner claimed.

Accordingly, we affirm the Examiner's decision rejecting claims 1 through 4, 7 through 9, 11 through 15, 18, 19, 21 through 24, and 27 under 35 U.S.C. § 102(e) as anticipated by or, in the alternative under 35 U.S.C. § 103(a) as unpatentable over, the disclosure of Harutyunyan.

## *II. OBVIOUSNESS*

Under 35 U.S.C. § 103, the factual inquiry into obviousness requires a determination of: (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). “[A]nalysis [of whether the subject matter of a claim would have been obvious] need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *KSR Int'l Co., v. Teleflex, Inc.*, 127 S. Ct. 1727, 1740-41 (2007); see also *DyStar Textilfarben GmbH*

& Co. Deutschland KG v. C.H. Patrick Co., 464 F.3d 1356, 1361 (Fed. Cir. 2006).

*1. Claims 5, 6, 16, 17, 25, and 26 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Harutyunyan and Fliflet<sup>2</sup>*

The disclosure of Harutyunyan is discussed above. As acknowledged by the Examiner, Harutyunyan does not teach using a magnetron as its microwave source (Ans. 4, 16, and 18). Appellants contend that the applied prior art do not provide any reason, suggestion or motivation to employ the magnetron as the microwave source for Harutyunyan's microwave heating process.

The dispositive question is, therefore, whether one of ordinary skill in the art would have been led to employ, *inter alia*, a magnetron as the microwave source in Harutyunyan's microwave heating process within the meaning of 35 U.S.C. § 103(a)? On this record, we answer this question in the affirmative.

As correctly found by the Examiner at pages 14, 16, and 18 of the Answer:

Like Harutyunyan, Fliflet teaches microwave heating. Fliflet teaches a NRL 2.45-GHz microwave furnace system wherein the microwave source is a Cober S6F 2.45 GHz industrial magnetron-based source which can produce *up to 6 kW* of continuous wave (CW) power and the microwave cavity is a

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<sup>2</sup> Appellants argue the limitations recited in claims 5, 16, and 25 (App. Br. 24-26 and Reply Br. 11-13). Therefore, for purposes of this appeal, we decide the propriety of the Examiner's rejections based on these claims alone consistent with 37 C.F.R. § 41.37(c)(1)(vii) (2005).

*TE<sub>103</sub> rectangular wave guide mode* (pages 1042-1043...) [Emphasis original]. [FF 4].

Given the above teachings, we concur with the Examiner that one of ordinary skill in the art would have been led to employ known microwave generating devices useful for microwave heating, such as the magnetron taught by Fliflet, in the microwave heating process of Halutyunyan, with a reasonable expectation of successfully heating catalyst residue impurities in the carbon nanotubes taught by Halutyunyan. *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. at 1740 (*quoting Sakraida v. Ag Pro, Inc.*, 425 U.S. 273, 282 (1976)) (“[W]hen a patent ‘simply arranges old elements with each performing the same function it had been known to perform’ and yields no more than one would expect from such an arrangement, the combination is obvious.”); .

Accordingly, we affirm the Examiner’s decision rejecting claims 5, 6, 16, 17, 25, and 26 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Harutyunyan and Fliflet

*2. Claims 10 and 20 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Harutyunyan and Holzinger*

The dispositive question here is whether the Examiner has demonstrated that one of ordinary skill in the art would have been led to chemically functionalize Harutyunyan’s carbon nanotubes prior to the removal of its catalyst residue impurities within the meaning of 35 U.S.C. § 103(a)? On this record, we answer this question in the negative.

As is apparent from page 4002 of Holzinger, nanotubes are chemically functionalized after they are purified. (FF 5). There is no

indication in either Harutyunyan or Holzinger that the chemical functionalization of carbon nanotubes can be carried out in the presence of Harutyunyan's catalyst residue impurities. (FF 6). Therefore, we concur with Appellants that the Examiner has not demonstrated that one of ordinary skill in the art would have been led to chemically functionalize Harutyunyan's carbon nanotubes, prior to its catalyst residue impurity purification step, within the meaning of 35 U.S.C. § 103.

Accordingly, we reverse the Examiner's decision rejecting claims 10 and 20 under 35 U.S.C. § 103(a) as unpatentable over the combined disclosures of Harutyunyan and Holzinger.

### *III. OBVIOUSNESS-TYPE DOUBLE PATENTING*

Appellants do not challenge the Examiner's determination that claims 1 through 27 of the present application are unpatentable over the claims of copending Applications 10/764,092 and 10/738,168 filed Jan. 23, 2004 and Dec. 17, 2003, respectively. Accordingly, we summarily affirm the Examiner's decision provisionally rejecting claims 1 through 27 under the judicially created doctrine of obviousness-type double patenting as unpatentable over the claims of copending Applications 10/764,092 and 10/738,168 filed Jan. 23, 2004 and Dec. 17, 2003, respectively.

### *ORDER*

The decision of the Examiner is affirmed.

### *TIME PERIOD*

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

PL Initial:  
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